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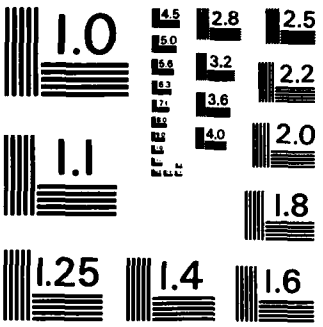

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The Alvey Conference in Edinburgh: A Review of the UK's Research Program in Computer Science

J.F. Blackburn

22 August 1985

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A conference to review the UK's Alvey Program of research in computer science was held in Edinburgh from 24 through 27 June 1985. This report summarizes the speakers' comments about the progress of the Alvey Program.

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THE ALVEY CONFERENCE IN EDINBURGH: A REVIEW OF THE UK's RESEARCH PROGRAM IN COMPUTER SCIENCE

A conference to review the Alvey Program of research in computer science was held in Edinburgh from 24 through 27 June 1985. For background on the Alvey Program, see ONR, London, report R-11-84.

Keynote Address

In the keynote address, Sir Ronald Mason, professor at Sussex University, analyzed the present state of the information industry in Europe and suggested some steps to be taken. His comments are paraphrased below.

The prospects for the information technology industry in the future in Europe will depend on the will and ability of the nations and Europe as a whole to put into practice the technical advances that have been made and are being made. Future growth in the industry in Western Europe and in the UK must be based on putting high technology into practical use. The primary resources lie in the skills and innovations of the people in the academic community and in industry. The European record in application of technology is patchy. In information technology the record is less impressive than it is in chemistry, for example. There does not appear to be an integrated total approach to the problems in the electronics sector. We need to consider and apply our knowledge to information systems rather than just to information technology.

The Alvey Program has completed the initial phase of an effort needed to be precompetitive, but now we need to take the next step. We need to apply what has been learned.

The race is between Europe, Japan, and the US, and we, in Europe, need a European approach. We, at present, suffer from too much fragmentation of the market and of our research and development efforts. This need is most obvious in high technology and in defense. In the US the Department of Defense is the major driver for high technology. The Strategic Defense Initiative (SDI) is directed toward new technology research in advanced communications, sensors, and optoelectronics. Europe's Eureka program has many objectives in common with SDI, but it is not clear whether the driver is defense or defense and technology. There is much political content in technology, and the question we must address is whether the UK and Europe can develop a "pull" based on economics.

The challenge is to achieve by the early 1990s strong technical competence in integrated circuits and software, open systems interconnection in communications, and a strong manufacturing industry. At stake is the competitiveness of industry. We must decide how to meet international competition. On this will depend the well-being of the future. The UK and Europe must react to the post-industrial revolution.

Overall Progress of the Alvey Program (Brian Oakley)

By the end of 1985 virtually all of the £350 million for the Alvey Program will have been committed. Committed funds as of now represent about 85 percent of the total. The decision to proceed was announced in May 1983; £350 million was committed, of which £200 million would come from government and £150 million would come from participating companies.

The staff members of the Alvey Directorate have come from the Department of Trade and Industry, the Ministry of Defense, the Science and Engineering Research Council, and industry. Of the 45 people in the directorate, 15 have come from industry, and they are funded by industry. There is a steering committee of 12, of which Sir Robert Telford is chairman.

We originally stuck to the four fields recommended in the Alvey Report: namely, very large scale integration (VLSI), man-machine interface (MMI), software engineering, and intelligent knowledge-based systems (IKBS). However, we later, in 1984, added computer systems architecture. Two areas of

relevant research that are not covered are optoelectronics and storage.

Unlike Japan's Institute for New Generation Computer Technology and the Microelectronics and Computer Technology Corporation in the US, we have no central laboratory. However, there will be a small laboratory for systems architecture.

At present 102 full industrial projects and 72 academic projects have been funded. More than 60 firms, 40 universities, six polytechnical institutions, and five government research establishments are participating in these projects.

In VLSI most funds are committed, and in VLSI computer-aided design (CAD) about 75 percent of the funds have been committed. Thus far in software engineering only 16 projects have been funded. There appears to be a shortage of experienced staff in this field. In the MMI field about 60 percent of the funds have been committed, covering pattern recognition, speech recognition, display devices, and human factors. IKBS, which includes expert systems, was strongly represented in the demonstrator programs. A coordinator for systems architecture, Ronan Sleep, has been appointed.

One important achievement, thus far, is the promotion of communication and cooperation between universities and firms. Seventy are represented in VLSI alone. Also we expect to shortly have communication links with the European Economic Community's (EEC) ESPRIT program of research in information technology.

Two questions have been raised about the Alvey Program. One question is why it is not application oriented. It was not designed as an implementation and application program. The other comment has been that there are too few small firms in the program. We found the resources required exist primarily only in big firms.

One real problem is the financial one within the Science and Engineering Research Council, which at present has a cash-flow problem. Another problem is that of the bureaucratic complication of dealing with several different government entities for approval of agreements and administration of contracts.

Three groups, or "clubs," have been organized to evaluate aspects of the Alvey program. A club called PREST, at Manchester University, will evaluate the organization of the program. A club called SPRU, at Sussex University, will evaluate strategies relative to competition; and a club called CBS, at London Business School, will evaluate strategies and impact on firms.

VLSI and CAD (Dr. W. Fawcett)

The objective of the VLSI and CAD sector of the Alvey Program is to carry out the research necessary to establish by the late 1980s internationally competitive VLSI processes within the UK. The program is carrying out coordinated research on a range of leading-edge technology options together with advanced CAD tools. Collaboration and dissemination of information between Alvey participants is a central feature of the program. Demonstrator circuits have been and are being fabricated as demonstrators. Important criteria will be the degree of technology advancement and the significance of the circuits to applications of information technology products.

A main objective of the research is to demonstrate 1-micron geometry metal oxide semiconductor (MOS) and bipolar processes within 5 years. This target requires assembly and optimization of individual process steps into a coherent and characterized process with established process and design rules, and the fabrication of prototype units. The circuit feature size was chosen to represent the limit set by the most advanced optical lithographical techniques available. As an intermediate step, 1.5-micron geometry circuits will be demonstrated during the second year. Longer term research will be carried out on aspects of technology and devices relevant to submicron geometries.

Silicon technology will be the basis for the research. A number of

different processes for fabrication are being covered:

- A basic complementary MOS (CMOS) process for logic and memory with negative MOS memory availability available as an option and variants as necessary for efficient static and dynamic random access memory, improved analogue capability, and nonvolatile storage.
- A CMOS process capable of meeting military requirements, almost certainly silicon-on-insulator with CMOS-silicon on sapphire as the first variant.
- Basic bipolar processes for logic and memory with variants for high speed, lower power, high density or improved analogue capability.
- A special made-to-order interface bipolar process.

Eighty-two applications have been received to date, of which 45 have been approved and six are still under consideration. Of those approved, 40 are in layer processing techniques and five are in whole process fabrication, including CMOS and bipolar. Twenty-one companies, 28 universities, and five research establishments are included in the approved VLSI projects. Of the budget of £95 million the committed amount is £73 million to full industrial projects, £7 million to universities, and another £7 million is reserved for imminent projects, leaving a further £8 million for future commitment.

Adequate CAD tools and systems are crucial to the efficient design of VLSI circuits. The objective of the CAD program takes into account the increased complexity anticipated through technology advancements as well as projected system requirements. A supporting infrastructure needs to be available in the UK at reasonable cost. Areas of support include system specification languages, design verification, system simulation, device and process modeling programs, design synthesis, design analysis, design methodologies, system specification languages, simulation and verification tools, a hierarchical automated cell-based system, and an advanced VLSI custom design system.

For the CAD work, 34 applications have been received, of which 12 have been approved, and eight are under consideration. Fourteen companies and two research institutes are represented in the approved projects.

VLSI architecture, with a budgeted amount of £8 million has £7.6 million committed to areas including parallel processing, systolic arrays, and fault tolerance.

Software Engineering (D.E. Talbot)

The software engineering program intends to establish tools and methods necessary for the production of high quality, cost effective software of world-leading standard. Three vital objectives of the program are:

1. Exploitation--efforts are needed to ensure that existing methods are effectively used and their benefits gained by industry as a whole. Continuing efforts are needed to bring the fruits of research out into industrial use with the associated investment and training.

2. Integration--work must be directed to establish the development of integrated methods and sets of tools for hardware and software development covering all phases of the system life cycle. The focus of the work will be the production of the Information Systems Factory, in which the UK will aim for technical leadership.

3. Innovation--programs of research and development will be needed to extend the methods and techniques of software engineering. This set of programs will serve to establish a sound basis for the work undertaken in integration and exploitation activities.

For this program 110 applications have been received, of which 58 were approved. Sixty percent of the budget (or £4.2 million) has been committed.

IKBS (Dr. D.B. Thomas)

Four IKBS demonstrator projects have been approved and are well under

way: (1) IKBS applications in simulation and avionic tactical decision aids, (2) IKBS applications for mechanical health monitoring, (3) business applications of expert systems, and (4) expert assistance in product formulation.

For the regular Alvey Program in IKBS, 160 applications have been received, of which 60 have been approved and a further 30 are under consideration. Thirty-three companies and 33 universities are involved in the approved projects. These projects together with the financial commitment are shown in Table 1.

MMI (C.W.M. Barrow)

The MMI research will include human interface, speech technology, image processing, and displays. In human interface, of 75 proposals submitted 12 have been approved, and a further 15 are under consideration. Fifty percent of the budget has been committed.

In speech technology, of 23 proposals received, nine have been approved and four more are under consideration. Eighty percent of the funds have been committed. The four under consideration would make 100 percent.

In image processing, the key areas are feature extraction, segmentation, shape from gray scale, texture, registration, and motion analysis. Of 28 proposals received, eight have been approved and a further seven are under consideration. Fifty percent of the available funds have been committed.

Table 1

IKBS Project Funding

Category	Number of Projects	Funding (millions)
Expert systems	18	£ 2.6
Natural languages	8	0.5
Vision	4	1.8
Logic programming	8	1.3
Declarative systems	18	16.4
IKBS demonstrators	4	3.1
	60	£25.7

In display, the aim is to develop a flat and thin display device. Five projects are under consideration.

Infrastructure and Communications in the Alvey Program (D.L.A. Barber)

The role of the Alvey Directorate is now moving from the identification of strategy and the selection of projects, to the management of the program. The Infrastructure and Communications (I&C) Directorate is responsible for a program in communication research, for the development of an associated high-speed network, and for the provision of common infrastructure support services.

Background. The staff and initial support available to each directorate in the Alvey Program differed and depended on the events that led up to the establishment of the program. A great deal of groundwork had been done in IKBS by the academic community, and software engineering was able to build on the Software Technology Initiative already being managed by the Rutherford Appleton Laboratory. There was a very active group in human factors relevant to MMI, and there were existing programs in VLSI in the Ministry of Defense and the Science and Engineering Research Council.

Computing infrastructure is particularly important to IKBS and software engineering, so one of the first decisions of the Alvey Board was to purchase a number of multiuser minicomputer systems. These include 10 GEC Series 63 machines and five System 8750 machines, with UNIX operating systems supporting Prolog, Lisp, and Poplog language development environments. These systems are all connected to the British Telecom Public Packet Switchstream Service (PSS) and so may intercommunicate using the standard UNIX protocols. A decision has been made recently to add single user workstations.

Approach. Discussions have begun on how interworking and interaction between the projects can be achieved, where necessary. The architecture program has been established only in the past few months, but one of the major projects, Advanced Network Systems

Architecture, is aimed at defining the architecture and interfaces of general distributed system. Thus, a number of initiatives in infrastructure and communications have been taken by various directors in connection with their specialized areas.

Specialist facilities are relatively easy to identify and justify, but it has proved difficult to identify services that everyone will accept as being necessary to support the whole program. However, where common requirements could be clearly identified, timely and adequate provision has been made.

The three areas for common support services are: (1) support for the directorate staff in Millbank Tower, (2) the provision of services for the participants in the Alvey program projects, and (3) technical liaison with the European Commission.

Support at Millbank Tower. The first task of the I&C Directorate was to provide a local area network at Millbank Tower. The Xionics Xibus system was selected. It has served well for internal messaging, diary management, processing, and personal computing support, using applications packages running under an emulation of CP/M 80. The network is connected via a local Packet Assembler Disassembler to the PSS to allow communication with external services.

Services for Participants. The bimonthly *Alvey Newsletter* was created and it is edited and distributed by the Institution of Electrical Engineers to a mailing list of more than 5000.

For communication the PSS is the best support medium for the industrial participants, and the academic ones are well served by the academic private packet switched network operated by the Joint Network Team (JNT) at the Rutherford Appleton Laboratory. The JNT network (JANET) has gateways to the public switching system, which allow academic and industrial partners in Alvey projects to readily interact with one another.

An Alvey mail server similar to those operated by JANET runs on a GEC 4190 computer located at the National Physical Laboratory. The service is managed by an administration center, operated on behalf of the Alvey Directorate by British Telecom. The registered users now exceed 400. A directory of users and services available is being offered on a trial basis. The directory, called ALMANAC, will be available, via the PSS, to all Alvey participants issued with an identifier and password.

Liaison With the EEC. In ESPRIT, the EEC research program in information science, common infrastructure and communication facilities are provided in the form of the Information Exchange Service (IES). Technical liaison between Alvey and ESPRIT has taken the form of discussions aimed at linking the IES with Alvey services. EUROCOM is the ESPRIT principal mail and conferencing system. It is based on the COM system originally developed by the Swedish Defense Research Establishment in Stockholm. The Alvey mail server can communicate with the COM systems located in Stockholm and at the University of York, using the gateway facilities available at University College London.

Communications R&D. Two separate research projects, ADMIRAL and UNISON, have been formed. The partners in ADMIRAL (Advanced Meganet Internet Research for Alvey) are the GEC Research Laboratories, the British Telecom Research Laboratory, University College London, and the University of London Computing Centre. They will investigate protocols for connectionless and connection-based communications; study the integrated management of networks with autonomous administrations; and develop primitives for distributed computing applications. The cost is £3.2 million and the duration is 3 years.

The partners in UNISON (Son of UNIVERSE) are Logica VTS, Acorn Computers, the Rutherford Appleton Laboratory, the University of Cambridge, and Loughborough Technical University. This group will study local area network-based office systems, the handling of multimedia information, and user agent services, and will develop a high-speed local switch based on the Cambridge fast ring.

The cost of the project is £2.6 million and the duration is 3.5 years.

The Alvey High-Speed Network (Alvey Net). To meet the need for high-speed circuit and packet switching, two separate networks will be provided. However, the user will be unaware of this, because access to both would be through a single 2-Mb/s subscriber's loop. This links user access equipment, at the subscriber's premises, to a network controller at a network switching center. The implementation of the network will be done by a consortium of British Telecom, GEC, and Logica, with British Telecom being the prime contractor.

Alvey Architecture Strategy (Dr. R. Sleep)

The primary aim of the program is to integrate UK work on architecture, with emphasis on breaking down the traditional barriers between industry, academia, and government research establishments. A secondary aim is to amplify and exploit existing UK strengths to affect the marketplace of the early 1990s. A strategic decision was made to focus on VLSI technology and declarative methodologies. Three levels of architecture are involved: systems, subsystems, and circuits.

Systems architecture is primarily concerned with interfaces, standards, and concepts which allow effective interaction of subsystems. Technology for supporting communication between subsystems is the province of the C&I program described above. However, since systems architecture is central to Alvey architecture work, it is appropriate to support systems architecture projects which play a coordination role in this area. ANSO, funded at £4 million, is a hardware-oriented network system architecture; PISA, funded at £2 million, is a software-oriented architecture project.

Subsystems are information processing engines--e.g., central processing units and associated input/output equipment. The key components of a subsystem's architecture are a sensory data engine for gathering and preprocessing information from outside the system; an effector engine for postprocessing the decisions made by the whole subsystem; a knowledge manipulation engine, the new generation counterpart of a random access memory, but capable of more than read or write support; and an inference engine responsible for orchestrating the operation of the other components to achieve the overall functionality.

The UK is strong in the area of inference engines, and Alvey is building on the strengths of the Manchester Dataflow work and the Imperial College work on a graph reduction system, ALICE. The main focus for practical Alvey work is the ICL and Plessey-led parallel architecture project, which is integrating the work of these two university groups. This effort is funded at £15.5 million. Two smaller inference-engine projects are GRIP, funded at £480,000 on high-level hardware, and DACTL, funded at £360,000 for applications and languages for machines with parallel architecture.

Several projects on knowledge manipulation engines have been funded: CARDS (£1.6 million), FMUP (£460,000) and IFS (£250,000). Also. a project for (£250,000) has been funded at Strathclyde University to develop a deductive system based on the concept of connection machine in which each memory unit in a system of parallel processors is associated with its own processor. At the center of a connection machine is a routing system that selects which bits of memory must communicate with each other and when.

A project to simulate finite element graphics systems has been funded for £2.8 million. And a project called COBWEB, for wafer scale integration study, has been funded for £370,000.

Large Demonstrators (S.L.H. Clarke)

When the Alvey program began in June 1983, it was decided to devote about 10 percent of the available funds to a series of large-scale demonstrators. The systems were to be developed to a sufficiently advanced state to minimize the technical risks in proceeding to marketable products.

Four projects were chosen from 22 outline proposals. These projects, led by GEC, ICL, Plessey, and Racal, are described below.

Design to Product (GEC Electrical Products Ltd.). The two main objectives of this demonstrator are: to develop a design support environment for the design of small mechanical parts using IKBS techniques, and to show that the designed components can be machined and assembled automatically using instructions generated by the design support environment. The design-support environment is an integrated set of software packages which helps the user devise and detail a design. Users develop their designs from outline to detail using a built-in taxonomy of unit modules. At appropriate stages users can review their designs against criteria relating to machining, assembly, cost, and reliability. For each of these specialized areas, a detail knowledge will be contained within the designer system knowledge base. Once the design has developed sufficiently, it becomes possible to decide the physical shape of the part and produce the manufacturing data describing the machining and assembly of the product. These activities are supported by separate software packages called "the geometry engine," "the generation of machining data," and "the generation of assembly data."

ICL/DHSS (Department of Health and Social Services). The project is intended to show how decision support systems making use of advances in IKBS, MMI, and software engineering may be used to advantage in large organizations. As the target areas in DHSS, the project managers have selected: (1) eligibility for and assessment of the amount of DHSS supplementary benefit payments; and (2) support for adjudication officers dealing with claims in areas such as mobility allowance, invalidity benefit, and industrial injury benefit. Areas supporting claimants and also the Claimant Information Application, which deals with benefit advice, will be included. At this time a significant number of working papers on the analysis tasks and emerging designs are available. Also available are pilot software implementations of the mixed initiative scheme, the Gentle Educator for easy learning, two Browsers for locating relevant subsets of stored records, a decision-tree-based model for representation of rules, a form Helper framework, and a skeletal Policy Drafters Assistant.

Speech Input Word Processor and Workstation (The Plessey Company). The objective of this project is to demonstrate a large-vocabulary, general-purpose, English language speech input, text processing and management system designed to operate in a wide variety of general office environments without special acoustic conditioning. The project includes two complementary development activities. The speech input system based on advanced developments in phonetics, linguistics, and artificial intelligence, and the associated fifth-generation computer hardware required for real-time operation.

Mobile Information Systems (Racal Research Ltd.). The objective is to investigate and develop many new non-voice services for users of mobile, portable, and transportable communications systems based on cellular and conventional radio-telephone technology. The four main demonstrators are: route guidance; traffic information system containing an IKBS; a fault location IKBS on the electricity supply network; and the "Mobile Electronic Office" and complex value-added networks.

Minister's Address

Near the end of the program, Mr. Geoffrey Pattie, Information Technology Minister, said that the Alvey Program has shown a focused and collaborative effort that cannot be ignored by government or industry. Industry is working cooperatively with universities as never before, which Pattie hopes will lead to an irreversible trend.

He was pleased to see the cooperation with the ESPRIT program of the EEC, which should lead to a European information technology industry. Pattie wants to see an industrial working group

set up which would involve industry, universities, and government to promote key enabling technologies in information technology. He said that government assistance, as in Alvey, cannot necessarily be expected in the current form after the program ends in 1988. Other areas like optoelectronics and enabling technologies need to be considered. Pattie thought that perhaps Europe should concentrate on a very few areas in which competition with the US and Japan requires a large effort.

Conclusion

This conference served to acquaint all participants in the Alvey program and other interested parties with the overall objectives of the program and to give some idea of progress to date. Since the final results were not available from the projects, the progress to date was difficult to measure.

Some positive achievements thus far were:

1. All the major British companies in information technology and related fields are working, apparently effectively, with major universities. This had not happened before on this scale.

2. About 85 percent of the available funding has been committed to projects, and all is expected to be committed by the end of 1985. This shows good progress in making the necessary decisions required to engage the researchers.

3. The objectives, reviewed during the proceedings, appear to cover the field well with the addition of systems architecture, which came a year later than the other areas. A couple of areas, noted by Brian Oakley, that were not included are optoelectronics and storage. Good arguments can be given for including them. Clearly, very large storage capacity will be needed for IKBS. Also, optoelectronics is a leading-edge area in the information technology field and indeed is currently being implemented in some products.

Although difficult to determine from information given in open sessions, it appeared that most of the work is approximately on schedule. Nonparticipants in the program could not attend the closed sessions, which would have given more detail on individual projects and problems encountered.

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